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A NUMERICAL STUDY ON SIDE HULL OPTIMIZATION FOR TRIMARAN*

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Abstract: Due to the interaction between the main hull and side hulls, different layouts and lengths of side hulls affect the wave loads significantly. Based on three-dimensional potential theory and Green's function, this article gives the significant values for wave loads, including vertical shear forces and vertical bending moments at different locations on the main hull, and transverse bending moments at the junction of the cross structure and main hull. In addition, a parametric optimization of wave loads for different layouts and lengths of side hulls were perfomed. Several speeds and wave headings were also considered. Finally, spectral analysis was conducted to attain load distribution. The conclusions of this study are conducive to the design and optimization of this new type of ship.

Key words: trimaran, three-dimensional potential theory, wave loads, optimization

Introduction

Because of its unique structure, the trimaran possesses some significant advantages, including:

(1) Superior stability due to suitable layout of the side hulls. A trimaran can keep a high speed under high sea condition.

(2) Low wave resistance at high speed due to its slender ship hulls.

(3) Superior general arrangement due to its large open decks. The defense preparations can be arranged in a region which is not easy to damage.

(4) Strong survivability. Propeller's noise can be reduced because of the side hulls.

Since the British trimaran "Triton" was built in 2 000, many countries began to pay attention to this new type of ship[1-10]. There have been lots of research results, but most of these studies mainly focused on trimaran's motions[7-10]. The detailed study on wave loads of trimaran has not yet been seen in literature.

The wave loads of ship generally include shear force, bending moment, torsion moment and etc.. Vertical shear force and vertical bending moment are very important for structure analysis. For trimaran, additional due attention shall be paid on the transverse bending moment at the junction of the cross structure and main hull.

At present, the common method of calculating wave loads is strip theory[11]. However, because of the significant interaction between the main hull and side hulls, the strip theory may not be suitable for analyzing trimarans, in which the interaction between strips along the ship length is not considered. Also it is too complicated to analyze the interaction among three hulls in strip theory. Therefore, few investigators have used strip theory to analyze trimarans. In this article, three-dimensional potential theory[12,13] and Green's function are applied. A time domain method[14] is used to analyze the wave loads for all cases. As the time domain results are very complex, they are transformed to frequency domain results through the Fourier transformation[15]. The present numerical study was performed with the SESAM.

1. Theoretical analysis

1.1 *Theoretical method for wave loads*

We assume that the trimaran travels at constant speed and direction in waves. The incident wave

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